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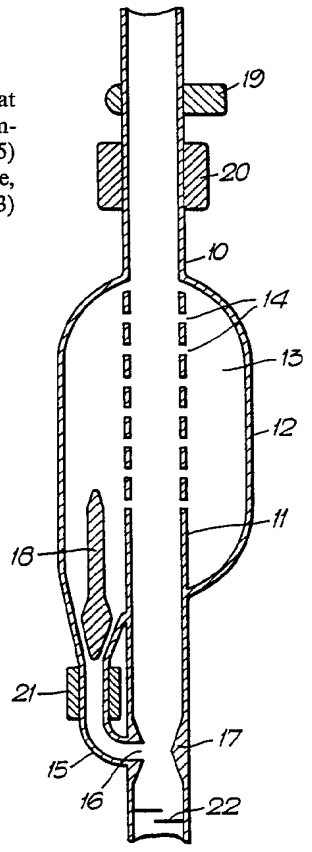
(54) Title: COMBINED SEPARATOR AND SAMPLER

(57) Abstract

A combined separator and sampler for use with a multi-phase fluid flow containing at least one gas phase and up to two liquid phases includes a flow pipe (10) and a separation chamber (13) connected to the flow pipe (10) by a plurality of perforations (14). A liquid conduit (15) connects the separation chamber (13) to a port (16, 30, 50) in the flow pipe (10) at which, in use, liquid pressure is higher than fluid pressure. In use gas returns from the separation chamber (13) to the flow pipe (10) through the perforations (14).



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COMBINED SEPARATOR AND SAMPLER

The present invention is concerned with the identification of the proportions of various fluids in a multi-phase fluid flow, with particular reference to the fluid flow from oil wells.

Fluid flow from oil wells normally consists of a mixture of oil, water and gas. It is important that the proportions of these constituents be identified as soon as possible to assist in the refining process, and also for fiscal reasons. In known apparatus for measuring the various proportions of these constituents, for example in US Patent 4,429, 581, the total flow is homogenised and the mass flow measured; the total flow is re-homogenised and its density and temperature measured; and then a proportion of the flow is by-passed to a separator where the gaseous and liquid components are separated, the liquid proportion thence passing through a net oil computer which analyses the proportions of oil and water. It is important that the fluid flow be homogenised, as is explained in UK Patent 2128756B, in order to prevent the various measurements from being compromised by the presence of bubbles or globules of individual components in the total flow.

It is desirable that flow measurement systems be positioned in pipelines adjacent to well heads. This is difficult in the case of sea bed oil wells as it has been found, in practice, that the separators required for separating the gaseous and liquid phases must be large and complicated.

There is therefore a requirement for a simplified separator for use in equipment for measuring the constituents of a multi-phase fluid flow.

According to the present invention a combined separator and sampler, for use with a multi-phase fluid flow containing at least one gas phase and up to two liquid phases, includes a flow pipe, and is characterised in having a separation chamber adjacent the flow pipe and connected thereto by a plurality of perforations, and a liquid conduit connecting the separation chamber to a port in the fluid flow pipe at which,

in use, the pressure of flow from the separation chamber is greater than the pressure of flow in the flow pipe.

In some embodiments of the present invention the combined separator and sampler is positioned such that, in use, fluid flow through the flow pipe is substantially vertically upwards. The separation chamber surrounds the flow pipe and the conduit extends from the bottom of the separation chamber to a port positioned at or adjacent a pressure reducing device such as, for example, a venturi in the flow pipe upstream of the separation chamber. In another embodiment the flow pipe is bent back on itself and the conduit extends to a port downstream of the separation chamber and of a pressure reducing device such as, for example, a valve.

In another version the multi-phase fluid flow passes horizontally along a flow pipe which is again bent back on itself, the separation chamber being attached substantially below the flow pipe and having a conduit leading vertically downwards to a port positioned in a venturi downstream of the separation chamber.

Appropriate instruments, well-known in the art, are positioned in or adjacent the fluid flow pipe and the liquid conduit to measure the quantities necessary to determine the proportions of the constituents, such as, for example, gas, water and oil, in the multi-phase fluid flow.

In some embodiments of the invention a mixer may be positioned in the flow pipe to ensure homogenisation of the fluid flow. This might be required, for example, to ensure that instruments such as volumetric flowmeters and density meters give representative readings.

In use a proportion of the fluid flow through the fluid flow pipe passes through the perforations into the separation chamber where the liquid portion settles to the bottom and gas separates out. The rate of flow into the separation chamber is controlled such that liquid returning from the separation chamber to the fluid flow pipe through the liquid conduit has completely separated from gas. The rate of flow into the separation chamber is controlled

by, for example, the configuration of the perforations, or by a valve controlling the flow of liquid through the liquid conduit. The valve might be, for example, a float valve or an electrically actuated valve controlled by liquid level sensors on the walls of the separation chamber. Alternatively a pump may be positioned in the liquid conduit.

Gas, having separated from the liquid, will be displaced upwards as the liquid phase drains downwards, and will return to the fluid flow within the flow pipe through the perforations.

According to another aspect of the invention a method of measuring the flow rates of a gaseous phase and up to two liquid phases in a multi-phase fluid flow through a flow pipe in which the flow rate and density of the fluid flow through the flow pipe are measured, in which a sample of the flow is processed to separate the gaseous and liquid phases, appropriate measurements of the liquid phase or phases being taken to determine the constitution thereof, the gaseous and liquid phases of the sample then being returned to the fluid flow, and in which the various measurements and known densities of the gaseous and liquid phases are treated to give the flow rates of each phase, is characterised in that the sample passes through a plurality of perforations in the flow pipe into a separation chamber adjacent the flow pipe, gas is allowed to return to the fluid flow through the perforations, and liquid is returned to the fluid flow through a liquid conduit connected to a port in the flow pipe at which the liquid pressure is higher than the fluid pressure.

Some embodiments of the invention will now be described, by way of example only, with reference to the accompanying diagrammatic drawings, of which

Figure 1 is an elevation, in section, of a first embodiment of the invention,

Figure 2 is an elevation, in section, of a second embodiment of the invention, and

Figure 3 is an elevation, in section, of a third embodiment of the invention.

A fluid flow pipe 10 (Figure 1) has a length 11 surrounded by

a casing 12 defining a chamber 13. The chamber 13 is connected to the inside of the fluid flow pipe 10 by perforations such as those shown at 14. A conduit 15 extends from the bottom of the chamber 13 to a port 16 positioned at the mouth of a venturi 17 in the fluid flow pipe 10. A float valve 18 is positioned in the mouth of the liquid conduit 15. A mixer 22 is positioned in the fluid flow pipe 10 upstream of the chamber 13.

A density meter 19 and a volumetric flow meter 20 are positioned around the fluid flow pipe 10, and a water content meter 21 is positioned around the conduit 15.

In use the fluid flow pipe 10 is connected to the output of an oil well, and the section having the chamber 13 is positioned substantially vertically such that the fluid flow output from the well passes vertically upwards through it. A proportion of the fluid flow through the pipe 10 passes through the perforations 14 into the chamber 13. The rate of penetration of the chamber 13

is adjusted, by design of the perforations 14, by design of the float valve 18 or both, such that it separates into liquid and gaseous components. The liquid component flows past the float valve 18, past the water content meter 21 and through the port 16 back into the main flow through the pipe 10. Similarly the separated gas flows back through perforations 14 into the main flow. The readings of the density meter 19, volumetric flow meter 20 and water content meter 21 enables the proportions of gas, water and oil in flow thorugh the pipe 10 to be accurately determined.

In a modification of this embodiment of the invention (Figure 2) the flow pipe 10 is bent back on itself as illustrated at 25 and the conduit 15 is connected to a port 30 which, in use, is physically lower than the bottom of the chamber 13. In use liquid flows back into the fluid flow stream through the fluid flow pipe 10 under the effects of gravity, and this can be assisted by the presence of a valve 31, between the chamber 13 and port 30, to reduce the pressure in the pipe downstream of the valve 31.

In yet another form of the invention (Figure 3) the fluid flow pipe 10 is again bent back on itself in a U shape but is adapted to operate with horizontal fluid flow there through. A casing 42 defining a chamber 43 is positioned substantially below an upper leg 44 of the fluid flow pipe 10 with perforations 14 separating the chamber 43 and inside of the fluid flow pipe 10 as before. The conduit 15 leads to a port 50 at the mouth of a venturi 51 in a lower leg 45 of the fluid flow pipe 10. Other details of this embodiment are similar to those of the embodiments described above with refernce to Figures 1 and 2.

Instruments for providing the required data, such as the density meter 19, volumetric flow meter 20 and water content meter 21 are well-known in the art. Examples of suitable instruments are:

DENSITY METER

This can be a non-intrusive nucleonic density gauge such as manufactured by ICI Tracereo or an oscillatory device such as the FD810 manufactured by Sarasota Automation. Alternatively, it can be a semi-intrusive device such as the ID700 manufactured by Sarasota Automation or the NT1762 manufactured by Schlumberger Measurement and Control Ltd.

VOLUMETRIC FLOWMETER

This can be a non-intrusive device such as an acoustic Cross-correlation flowmeter as manufactured by Kents Industrial Measurements Ltd, or an acoustic transit Tome flowmeter, such as the Sparling A500 manufactured by Bestobell Mobrey. Alternatively, it can be an intrusive device, such as a venturi meter, orifice plate, turbine meter, drag plate etc, as manufactured by a range of companies.

WATER CONTENT METER

This can be non-intrusive such as the W1OM 300 Capacitance device manufactured by Fluenta A/S, or semi-intrusive such as the Aquasyst capacitance device manufactured by Endress & Hauser or the Series 4200/4202 capacitance device manufactured by Hydril Control Systems. Alternatively it could be a microwave device such as the OW-101 water monitor manufactured by the Agar Corporation or the new device anufactured by the Texaco Oil company. It could also be a coriolis Net Oil Computer device as licensed by the Chevron Oil company and manufactured by Micromotion and Exac companies.

Whilst the required flow rate from the fluid flow pipe 10 to the chambers 13, 43 has been described as being controlled by dimensions of the perforations 14 and design of the float valves 18 it will be realised that many alternative forms of control are possible. These might include, for example, electrically controlled valves in place of the float valve 18, these being controlled by liquid level sensors on the wall 12, 42 of the chamber 13, 43. Alternatively a pump may be positioned in the conduit 15.

It will be realised that alternative versions of the separator and sampler are possible within the scope of the invention. For example, in some embodiments there may be no need for a mixer 22. Also, in some instances where a mixer 22 is used it may be advantageous to position it, and any instruments 19, 20 for which it provides homogenisation, well upstream of the chamber 13. In a vertical multi-phase flow through a pipe there is a tendency for the liquid phase to separate to the wall of the pipe and the gas phase to separate to the centre. Such an effect in the vicinity of the perforations 14 will assist the separation task of the chamber 13.

CLAIMS

What is claimed is:

1. A combined separator and sampler, for use with a multi-phase fluid flow containing at least one gas phase and up to two liquid phases, including a flow pipe (10), characterised in having a separation chamber (13) adjacent the flow pipe (10) and connected thereto by a plurality of perforations (14) and a liquid conduit (15) connecting the separation chamber (13) to a port (16, 30, 50) in the fluid flow pipe, (10) at which, in use, the pressure of the flow from the separation chamber is greater than the pressure of flow in the flow pipe.

2. A combined separator and sampler as claimed in Claim 1 characterised in that the flow pipe (10) in the region of the separation chamber (13) is vertical.

3. A combined separator and sampler as claimed in Claim 2 characterised in that the liquid conduit (15) leads to a port (16) upstream of the separation chamber.

4. A combined separator and sampler as claimed in Claim 2 characterised in that the liquid conduit (15) leads to a port (30) downstream of the separation chamber.

5. A combined separator and sampler as claimed in Claim 1 characterised in that the flow pipe (10) in the region of the separation chamber is horizontal.

6. A combined separator and sampler as claimed in Claim 5 characterised in that the liquid conduit (15) leads to a port (50) downstream of the separating chamber.

7. A combined separator and sampler as claimed in any one of Claims 1 to 6 characterised in including a density meter (19) posi-

tioned to measure the density of fluid flow in the flow pipe (10).

8. A combined separator and sampler as claimed in any one of Claims 1 to 7 characterised in including a volumetric flowmeter (20) positioned to measure the flow through the flow pipe (10).

9. A combined separator and sampler as claimed in any one of Claims 1 to 8 characterised in including a water content meter (21) positioned to read the water content of liquid passing through the liquid conduit (15).

10. A combined separator and sampler as claimed in any one of Claims 1 to 9 characterised in that the rate of fluid flow from the flow pipe (10) to the separation chamber (13) is controlled by means including the size of the perforations (14).

11. A combined separator and sampler as claimed in any one of Claims 1 to 10 characterised in that the rate of fluid flow from the flow pipe (10) to the separation chamber (13) is controlled by means including a valve (18) between the separation chamber (13) and the liquid conduit (15).

12. A combined separator and sampler as claimed in Claim 11 characterised in that the valve (18) is a float valve.

13. A combined separator and sampler, as claimed in Claim 11 characterised in that the valve (18) is controlled by means including liquid level sensors on a wall (12) of the separation chamber (13).

14. A combined separator and sampler as claimed in any one of Claims 1 to 13 characterised in that the rate of fluid flow from the flow pipe (10) to the separation chamber (13) is controlled by means including a pump in the liquid conduit (15).

15. A method of measuring the flow rates of a gaseous phase and up to two liquid phases in a multi-phase fluid flow through a flow pipe in which the flow rate and density of the fluid flow through the flow pipe are measured, in which a sample of the flow is treated to separate the gaseous and liquid phases, appropriate measurements of the liquid phase or phases being taken to determine the constitution thereof, the gaseous and liquid phases of the sample then being returned to the fluid flow, and in which the various measurements and known densities of the gaseous and liquid phases are processed to give the flow rates of each phase, characterised in that the sample passes through a plurality of perforations (14) in the flow pipe (10) into a separation chamber (13) adjacent the flow pipe (10), gas is allowed to return to the fluid flow through the perforations (14), and liquid is returned to the fluid flow through a port (16, 30, 50) at which the liquid pressure is higher than the fluid pressure.

Fig. 1.

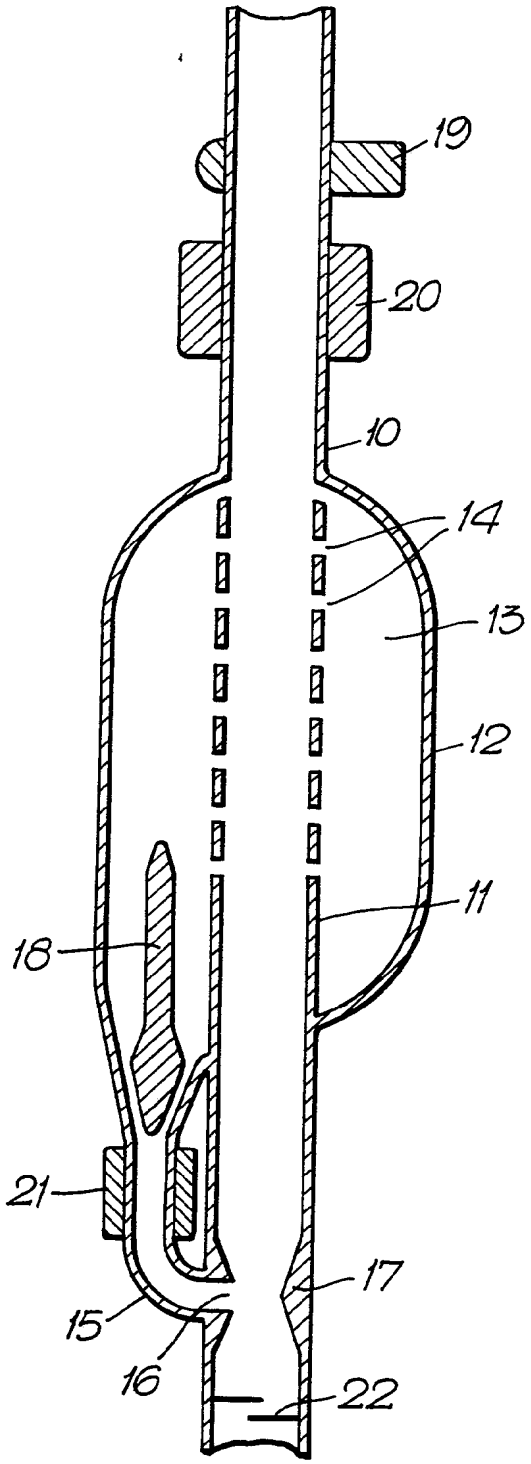


Fig. 2.

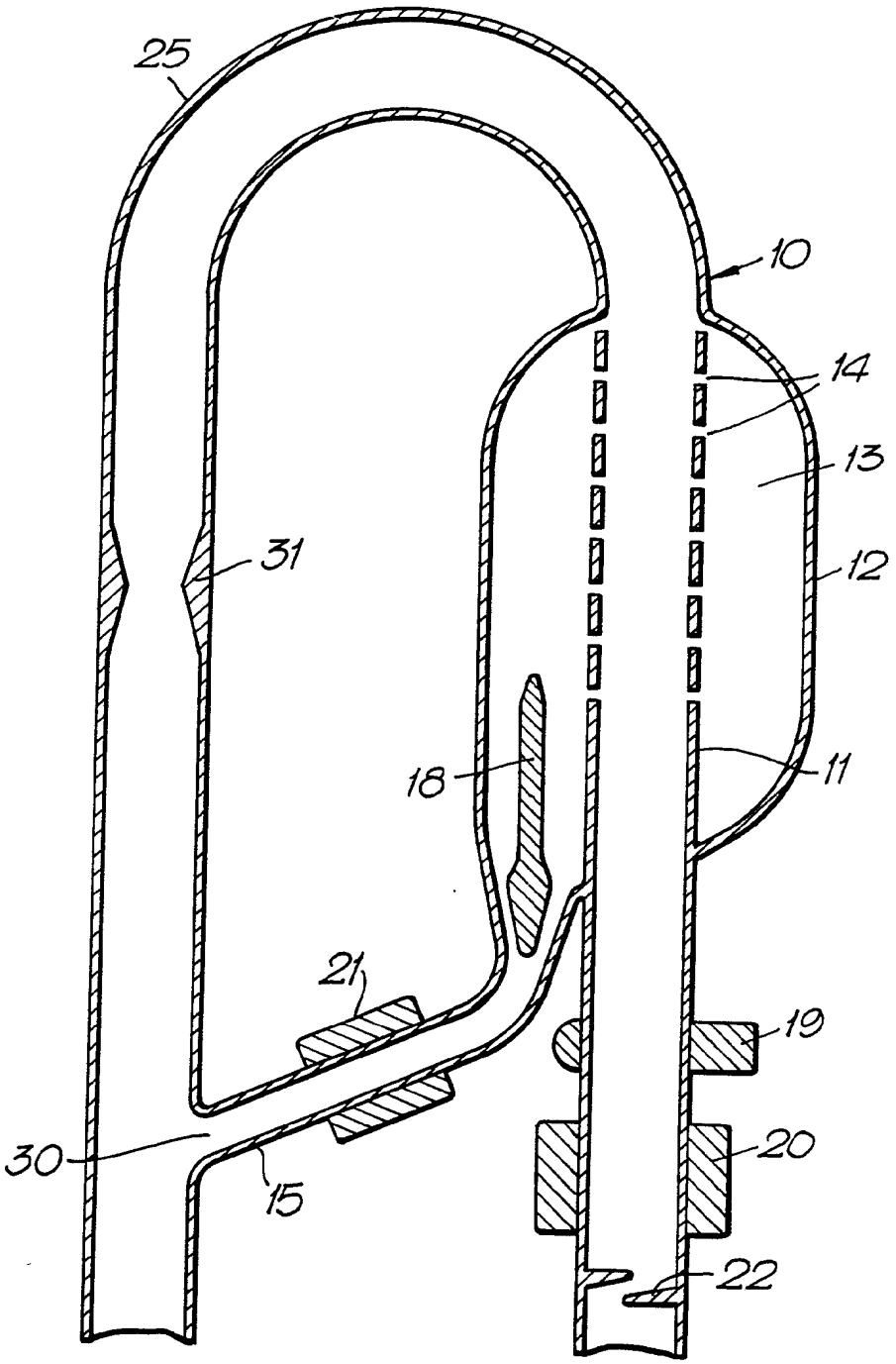
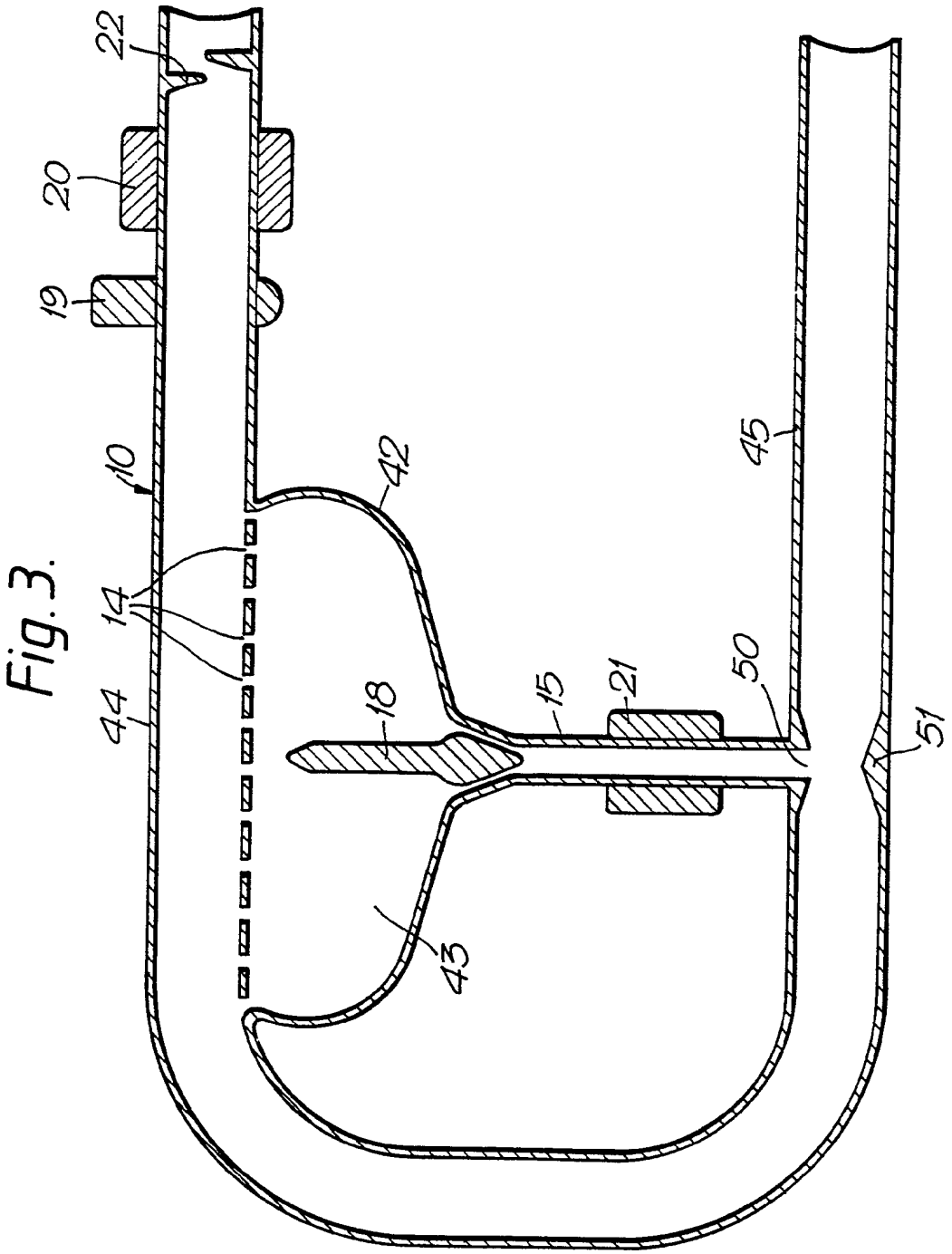


Fig. 3.



INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 90/01292

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC5: G 01 F 1/74,15/08, G 01 N 1/20

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
IPC5	G 01 F,N

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category *	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
P,A	US, A, 4881412 (R. NORTHEDGE) 21 November 1989, see claim 1 --	1-15
P,A	EP, A, 0332829 (VEGYIMÜVEKET EPITÖ ES SZERELÖ VALLALAT) 20 September 1989, see abstract --	1-15
A	US, A, 4760742 (G.J. HATTON) 2 August 1988, see abstract --	1-15
A	US, A, 4660414 (G.J. HATTON ET AL) 28 April 1987, see abstract --	1-15

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
7th November 1990	23. 11. 90
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	miss T. MORTENSEN

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
A	DE, C, 576838 (SIEMENS & HALSKE AKT-GES. IN BERLIN-SIEMENSSTADT) 4 May 1933, see page 1, line 6 - line 19 --	1
A	DE, C, 436858 (MABAG, MASCHINEN- UND APPARATEBAU-A.-G.) 10 November 1926, see page 1, line 12 - line 14 --	1

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. PCT/GB 90/01292

SA 39199

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 27/09/90 The European Patent office is in no way liable for theseparticulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 4881412	21/11/89	EP-A- 0213838	11/03/87
		EP-A- 0326231	02/08/89
		GB-A-B- 2179156	25/02/87
		GB-A- 2213405	16/08/89
EP-A- 0332829	20/09/89	NONE	
US-A- 4760742	02/08/88	EP-A- 0286259	12/10/88
		JP-A- 63316011	23/12/88
US-A- 4660414	28/04/87	DE-A- 3622669	19/03/87
		GB-A-B- 2180352	25/03/87
DE-C- 576838	04/05/33	NONE	
DE-C- 436858	10/11/26	NONE	